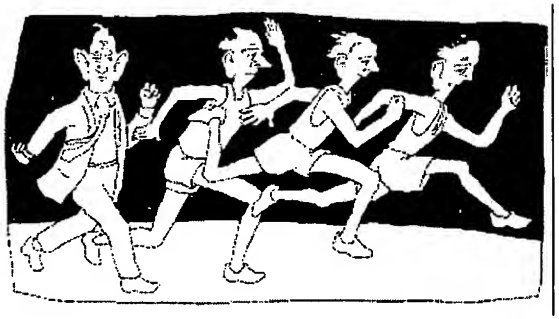
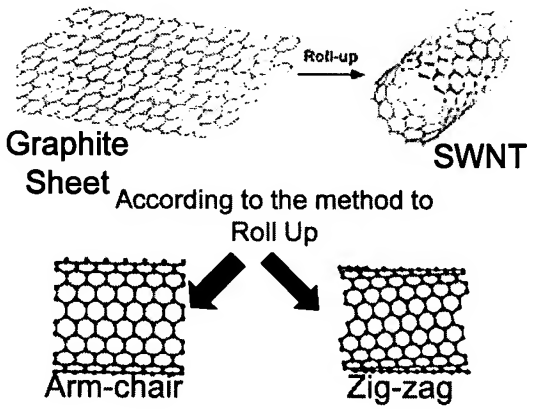
Differences between the invention and the references cited

2005.5.14

Jong Jin PARK

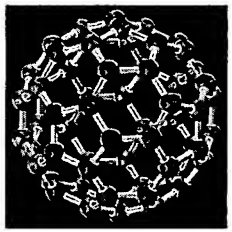
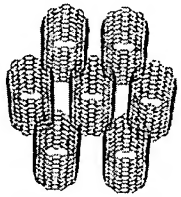


Properties of Carbon nanotube

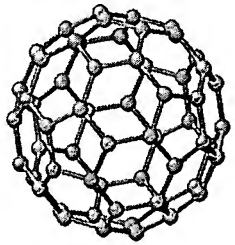
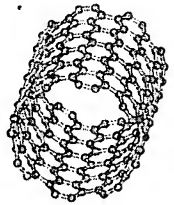
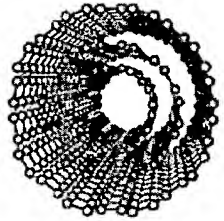
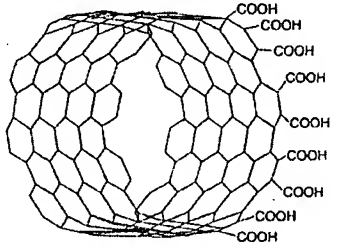
<table>
<tr><th>type</th><th>structure</th><th>Physical properties</th></tr>
<tr><td>Single Wall</td><td> 
</td><td>Size : 1000 times as small as commercial Carbon or Glass Fiber (CNT: ϕ1.4nm)

Electrical aspect : having Band Gaps properties.
-> Semi-conductive properties

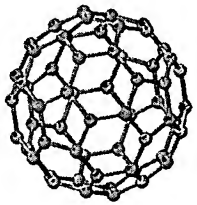
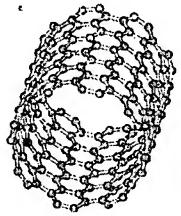
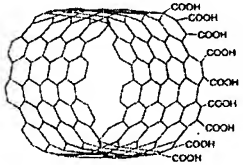
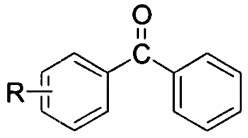
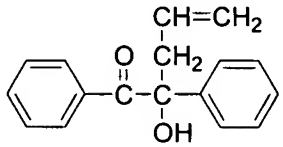
Mechanical aspect : High Aspect Ratio > 1000
(Max. 100um synthesizable)
Outstanding Strength

Conductivity : having metallic properties because of high electric and thermal conductivities.</td></tr>
<tr><td>Multi-Wall</td><td> 
Rolled-up with several sheets</td><td rowspan="2">Organic compound like a ball composed of carbon only :Buckyball
 
Function as electrical superconductor to insulator, depending on their combining structure.</td></tr>
<tr><td>Rope</td><td> 
Formed of rope of SW and MW</td></tr>
</table>

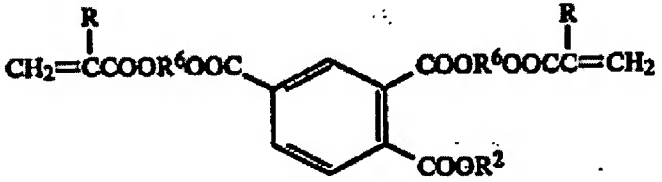
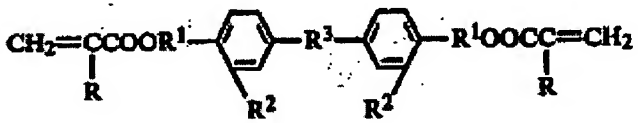
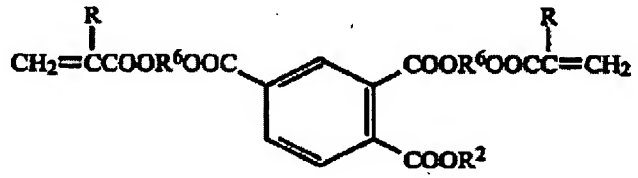
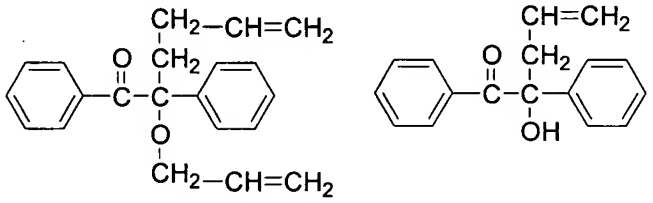
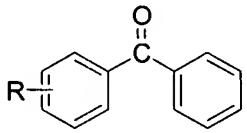
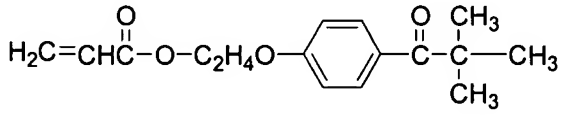
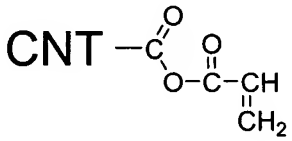
Comparison of C60 (Fullerene) with Carbon Nanotube

	Fullerene C_{60}	CNT
Structure	 **Ball Type of Carbon allotrope**	  Single wall Multi wall **Nanotube**
Surface treatment	Addition reaction *Chem. Rev.;* **1992**; *92*(7); 1487-1508.	Scission by acid reaction Acid functionalized and shortened by sonicating in a mixture (7:3) of HNO_3 and H_2SO_4  -scission occurs preferably at both sides with COOH result in oxidation - cut SWNTs into many short pieces. - broad distribution of opened-ended SWNTs.

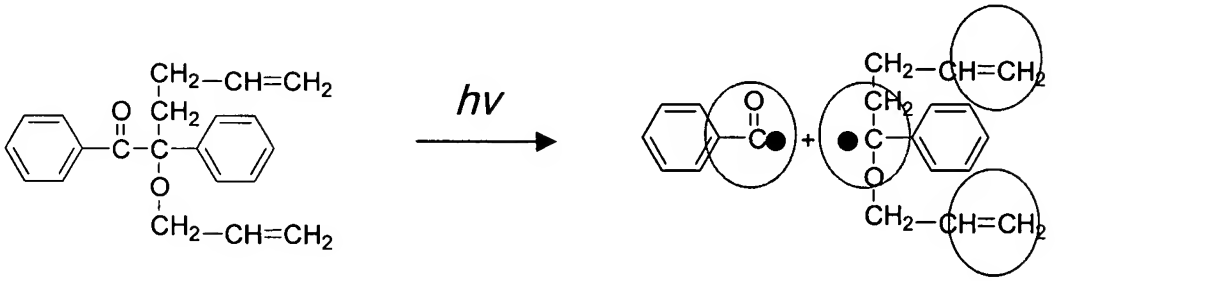
Comparison of US 5,561,026 with 10/713,254

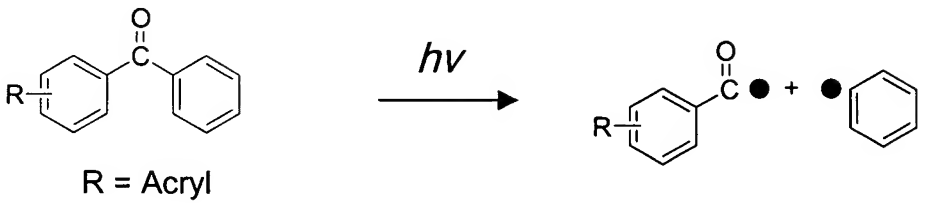
	US 5,561,026	10/713,254
Surface modification	Addition reaction  + Alkyl amine or Azido compounds → + Methacrylchloride → C60—NCH$_2$CH$_2$CH$_3$ (C=O, HC=CH$_2$)	Esterfication reaction  + By sonicating in a mixture (7:3) of HNO_3 and H_2SO_4 ↓  + Acryl chloride → CNT—C(=O)—O—C(=O)—CH=CH$_2$
Component		-Copolymerizable photo initiator  R = Acryl 

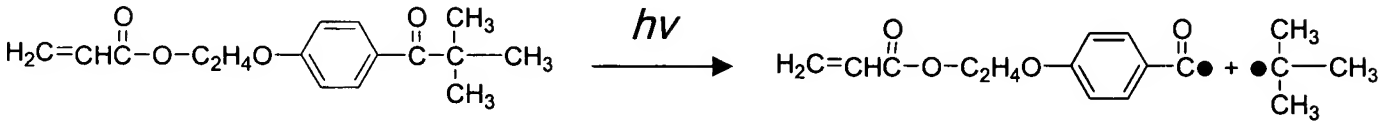
Comparison US 5,561,026 with 10/713,254

	US 4,439,291	10/713,254
Photosensitive compound	-One acryloyloxy or methacryloyloxy group   	Copolymerizable photo initiator   R = Acryl  

Copolymerizable photo initiator



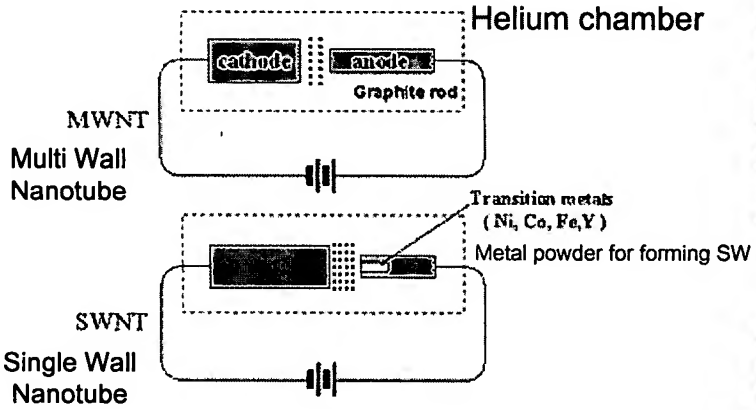




Comparison of CNT manufacturing method US 20010050219A1 with 10/713,254

❑ Synthesis of Carbon Nanotube used in the invention (1)

✓ Arc-Discharge



Two graphite rods are placed between the electrodes in He chamber (separated by less than 1mm)

⇩

Voltage is applied across the electrodes (20V~40V, 50A~100A)

⇩ The arc occurs

Plenty of electrons move to the anode and impact with graphite rod.

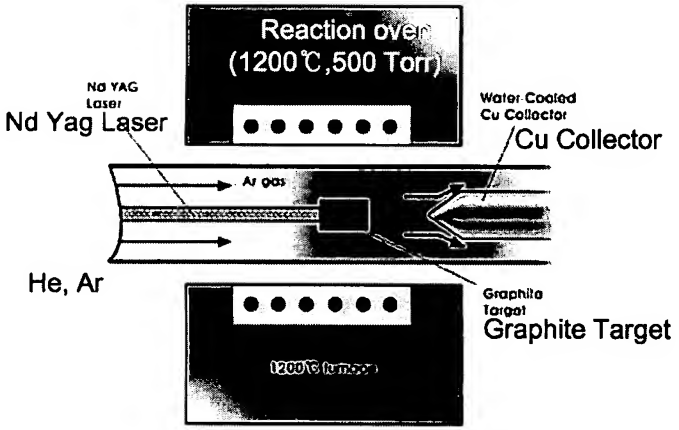
⇩

Carbon Clusters are condensed on the cathode

⇩ Low temperature on the cathode is necessary

Carbon nanotube is synthesized

✓ Laser Ablation (Laser Vaporization)



Laser is radiated to the graphite target

⇩ Vaporization of Graphite

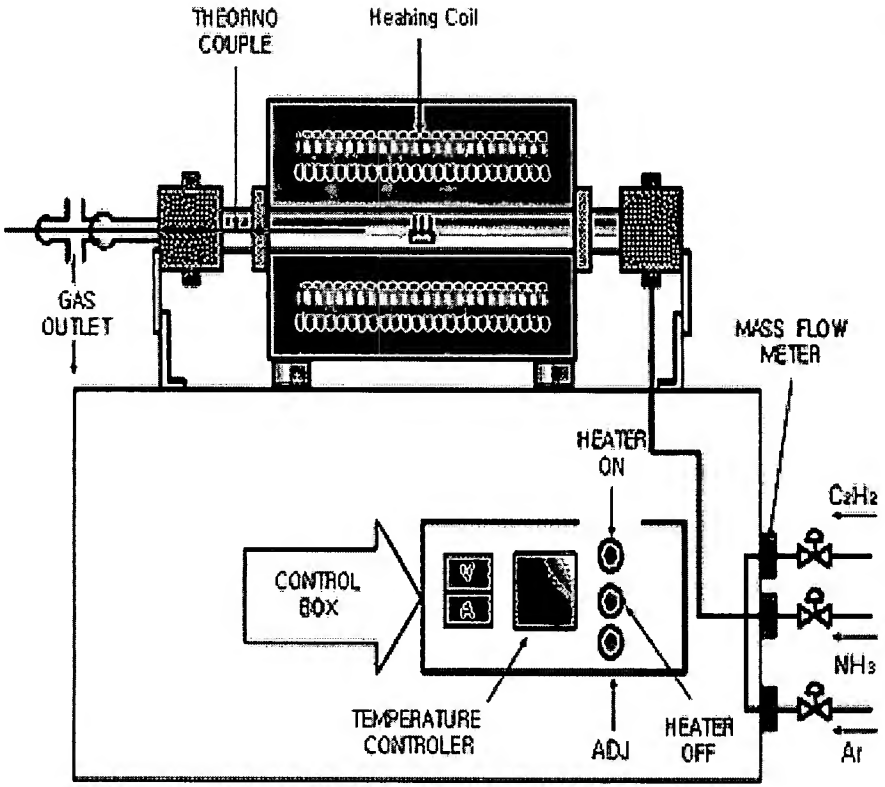
Vaporized carbon clusters are absorbed and condensed on the Cu Collector

⇩ Low temperature on the cathode is necessary

Carbon nanotube is synthesized

❑ Synthesis of Carbon Nanotube used in the invention (2)

✓ CVD,Chemical Vapor Deposition



The substrate of Si or Glass is metallized by catalyst metal (Fe,Ni,Co)

⇩

Metallized substrate is placed on the carrier, then injected to a reactor

⇩ 750℃ ~ 1050 ℃

Additional etching by using NH3 gas

⇩

Grain is formed on the surface of catalyst metal on the substrate

⇩ Gas of C2H2 injected

Carbon nanotube is synthesized

- Carbon nanotubes grow on the grain formed after etching
- Grain : Embossing type of surface

❑ Synthesis of Carbon Nanotube used in US 20010050219A1

✓ Low pressure with carboniferous liquid state

Summary

1. Differences with US 5,561,026
   -Fullerene is ball-type of carbon allotrope, which is surface-modified by additional reaction

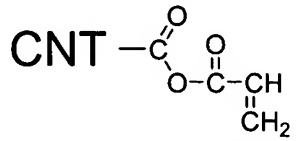
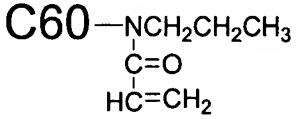
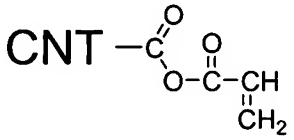
   -CNT is nanotube-type and it can be acid-functionalized and shortened, forming COOH at both sides
   Photosensitive groups are introduced on the surface by esterificating COOH and Acrylchloride

   -A photoinitiator in the composition is used, forming radicals and making UV-reaction easy. It is also involved in photopolymerization as a monomer to increase efficiency.

2. Differences with US 4,439,291
   -copolymeric photoinitiator is copolymerized with CNT substituted with photosensitive group.

3. Differences with US 20010050219A1
   -The invention can substitute all the surface of carbon nanotubes, so does not depend on the characteristic of each carbon nanotube produced by different methods. As a result, there is no relation to the invention.

Conclusions

Difference	US 4,439,291	10/713,254
Photosensitive Compound	-One acryloyloxy or methacryloyloxy group	-Photosensitive CNT  -Copolymerizable photo initiator -Copolymerizable monomer or oligomer
Difference	US 5,561,026	10/713,254
Surface Modification Method	-Addition reaction 	-Esterfication reaction 
Difference	US20010050219A1	10/713,254
CNT Making Method	-Low pressure with carboniferous liquid state	-Arc-Discharge -Laser Vaporization -CVD, Chemical Vapor Deposition